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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global sensitivity analysis of the GEOS-Chem chemical transport model: Ozone and hydrogen oxides during ARCTAS (2008)" *by* Kenneth E. Christian et al.

Anonymous Referee #2

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Christian et al. 2016 present a numerical sensitivity analysis employing the random sampling-high dimensional model representation (RS-HDMR) technique to understand how the uncertainty in a number of important parameters in the GEOS-Chem model affect the simulated abundances of ozone and the HOx (=OH+HO2) family in the Arctic during summer and spring. They find that the GEOS-Chem model results of ozone are fairly insensitive to the parameters that they have chosen to explore. Whilst the modelled HOx species show much greater sensitivity. Detailed analysis of the large ensemble of simulations using the RS-HDMR method identifies that the major source for model sensitivity for HO2 is owing to the large uncertainty in the uptake coefficient for HO2 onto aerosol.

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Discussion paper

The authors conclude that determination of the HO2 aerosol uptake coefficient remains an area for further study and that the best gamma value from their ensemble of simulations is lower than that used in the current version of GEOS-Chem.

In general this is a well written manuscript with nice clear figures. I think that the results are interesting and should stimulate some wider interest between the lab and modelling communities and recommend that this be published following appropriate response to the following concerns:

1) Number of parameters chosen: The authors state in the conclusions that 52 parameters have been explored. In Table 1 I count 51. Have I missed something? Can the authors please check this.

2) Model resolution: The current simulations have all been performed at 4ËŽ x 5ËŽ horizontal resolution with the justification that the authors found only small differences (∼10%) using higher resolution model simulations (2ËŽ x 2.5ËŽ). These latter higher resolution simulations still strike me as being very low resolution. Do the authors expect the same sensitivity to hold at say 0.5ËŽ x 0.5ËŽ? I ask as I have seen more and more simulations with GEOS-Chem at these sorts of high resolutions and so I think transferring the knowledge gained here to those studies is important.

3) Meteorological uncertainty in the model: This is out of interest, but how different is the uncertainty between the average monthly fields between GEOS-4 and GEOS-5 compared to the standard deviation of the meteorological parameters generated from the re-gridding from the native GOES-5 grid to the GEOS-Chem grid?

4) The role of organic radicals: It's interesting to see that the uncertainty in isoprene emissions pops up as having an effect on ozone and HO2. I was wondering if the authors considered the uncertainty in the organic peroxy radical reactions associated with isoprene?

5) NOx: There is very little mention of the role of NOx in the manuscript and I'm sur-

prised that the authors did not include NOx in the analysis and results. Clearly NOx plays an important role in coupling HOx and I would like to see how the current study impacts the NOx partitioning. I think that this is something that many others would also benefit from seeing and I would suggest adding some plots to at least show the impact of the ensemble of simulations on the NOx profiles.

6) Normalised sensitivities: It's not clear to me if the reason that HO2 uptake is the most sensitive parameter is owing to the fact that it has the greatest uncertainty? Can the authors comment on the use of the method in distinguishing/determining normalised sensitivities?

Technical corrections:

Page 2 line 4: I don't think Wu et al., 2007 is a great reference for making this point. A better reference would be a multi model intercomparison study like one of the ACCMIP or HTAP papers.

Page 9 line 13: ppb should be ppt I think.

Page 9 line 22: Need to define HOx earlier in the text.

Page 10 line 10: ppb should be ppt I think.

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